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SOLID RADIOACTIVE WASTE RETRIEVAL TEST

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Allied Chemical

Date Published - May 1972

PREPARED FOR THE
U.S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE UNDER CONTRACT AT (10-1)-1375 S-72-1

ACI-120

Waste Disposal and Processing
TID-4500

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ABSTRACT

The Atomic Energy Commission requested the Idaho Chemical Programs - Operations Office of Allied Chemical Corporation to perform a series of waste retrieval tests on Rocky Flats waste stored at the National Reactor Testing Station (NRTS) Burial Ground, to gain insight into problems that may arise in a large-scale exhuming operation. The tests demonstrated that solid wastes stored at the NRTS Burial Ground can be exhumed and handled safely.

SUMMARY

A series of waste retrieval tests on Rocky Flats wastes stored at the NRTS Burial Ground have been completed. The purpose of the tests was to determine the condition of waste and waste containers, soil migration of the plutonium contaminants, difficulties of controlling contamination spread during retrieval, and cost of retrieval. Buried waste containers at the NRTS Burial Ground were found in a wide variety of conditions. Some of the barrels were in excellent condition, while others were corroded through. It was apparent that damage to the barrels during the original dumping operations was extensive and resulted in many open barrels. Plywood boxes and cardboard cartons were deteriorated to the extent that they had no containment value. Nevertheless, no insurmountable retrieval problems were encountered.

Sixteen Rocky Flats waste barrels were opened and sorted at the ARA-I Hot Cell out of about 200,000 at the burial ground. The barrels were 80% full, and the contents consisted of 63% combustible and 37% non-combustible material. Efforts to exhume a plywood box of waste were unsuccessful. Removal of plywood boxes, and the waste therein, will require techniques different from those used for barrels. The boxes and their contents will probably have to be removed piece-by-piece.

This work showed that movement of plutonium into the soil from damaged containers was limited. The highest concentration of plutonium found at any distance from waste containers was about 1×10^{-4} μCi Pu/g soil at 3 ft below the containers. This concentration of Pu is about 1/100 the amount (10 nCi/g) recommended for continued burial at selected sites by the AEC's Task Force on Sorting of Solid Radioactive Wastes. "Hot-spots" of Pu contamination immediately adjacent to containers encountered were as high as 5×10^{-3} μCi Pu/g soil.

Contamination spread during excavation was not a severe problem. Dampness in the soil probably contributed greatly to minimizing airborne spread of contaminants. Winds, up to 20 mph, did not cause detectable contamination spread.

The direct cost of labor involved in large-scale exhuming of wastes was estimated at about $\$3.33/ft^3$ of waste, based on the results of the Solid Radioactive Waste Retrieval Test (SRWRT) program. It must be recognized that retrieval methods used were not necessarily optimal. Capital expenditures and administrative costs are excluded from this figure.

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SOLID RADIOACTIVE WASTE RETRIEVAL TEST
(SRWRT)

I. INTRODUCTION

About 2,500,000 ft^3 of the solid waste interred at the National Reactor Testing Station (NRTS) Burial Ground is transuranic-nuclide contaminated, low-level waste from the AEC's Rocky Flats operation. Because of the concern over long-term isolation, the AEC has elected to move this waste to a Federal repository. An operation of this magnitude presents many varied problems and may require extensive facilities. Therefore, the AEC requested the Idaho Chemical Programs - Operation Office of Allied Chemical Corporation to perform a series of solid waste retrieval tests at the NRTS Burial Ground to gain insight into the problems that may arise from a large-scale exhuming operation. The retrieval tests consisted of excavating and studying the contents of containers (barrels and boxes) from representative sites within the burial ground. In addition, the AEC requested that three specific barrels be retrieved from the burial ground and set aside for special analysis.

Figure 1 shows the location of the NRTS Burial Ground. The area was selected in 1951 after consideration of several other areas at the NRTS. Factors considered in the selection were (a) available area, (b) accessibility, (c) depth and texture of the regolith, (d) surface drainage, and (e) location in relation to existing reactor or plant locations[1]. The burial ground is approximately seven miles east of the western boundary and four miles north of the southern boundary of the NRTS. The fenced area originally contained 13 acres and was enlarged to 88 acres in 1957.

The basic objectives established for the Solid Radioactive Waste Retrieval Test were:

(1) Determine the condition of the buried packages and the waste therein,

(2) Determine the extent of leaching (migration) of radionuclides from waste exposed to the soil,

(3) Determine the techniques required for minimizing spread of contamination, and

(4) Determine retrieval costs.

Figure 2 shows the sequence followed in the program for the Solid Radioactive Waste Retrieval Test. In preparation for retrieval work, written procedures were prepared for safety consideration and review. During the test work, excavation sites were surveyed and marked, based on information obtained from NRTS Burial Ground records. The bulk of soil was removed using heavy equipment, and the final soil removal was mainly by hand-digging. The waste containers were transported by

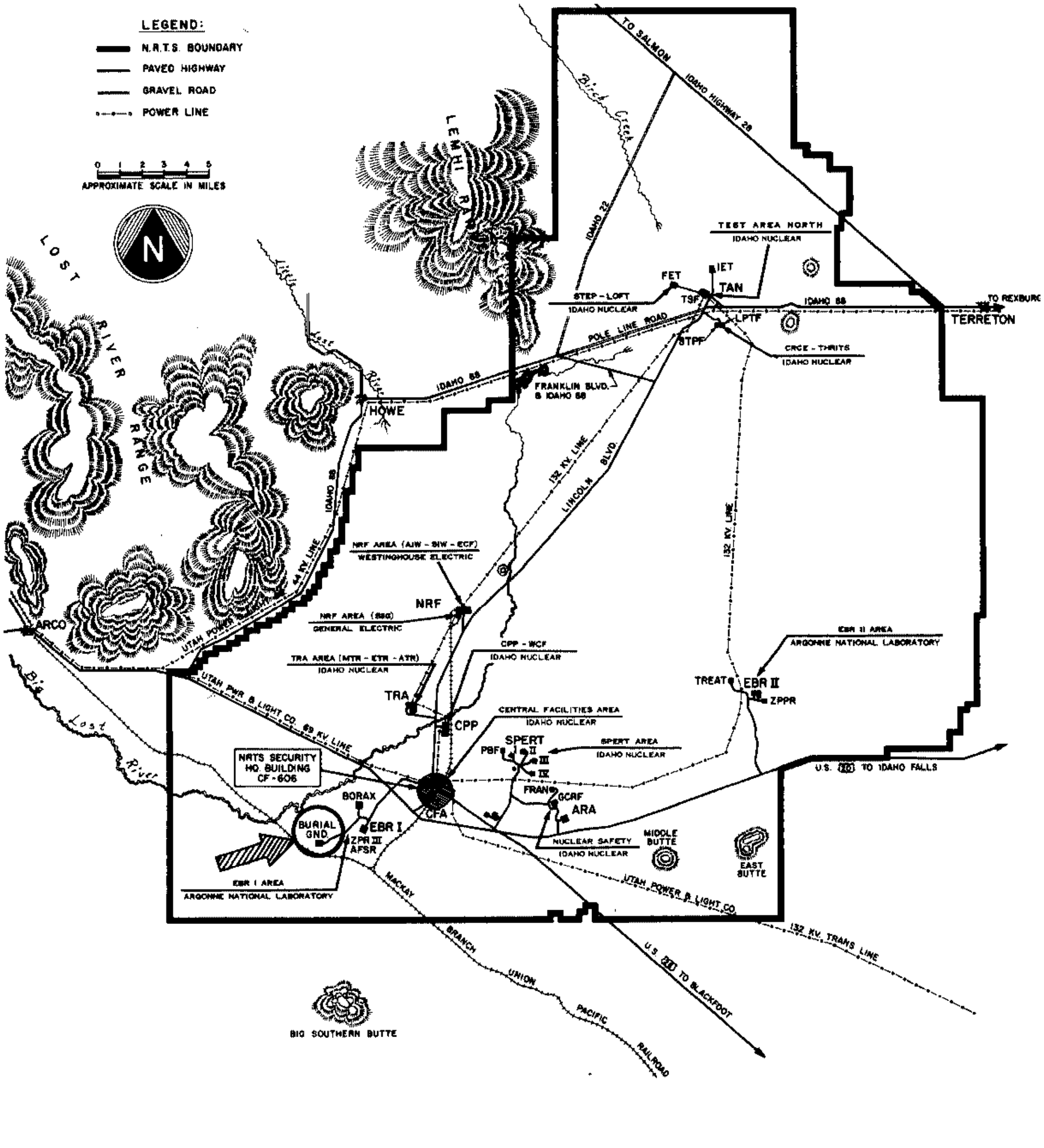

Fig. 1 Location of the NRTS Burial Ground.

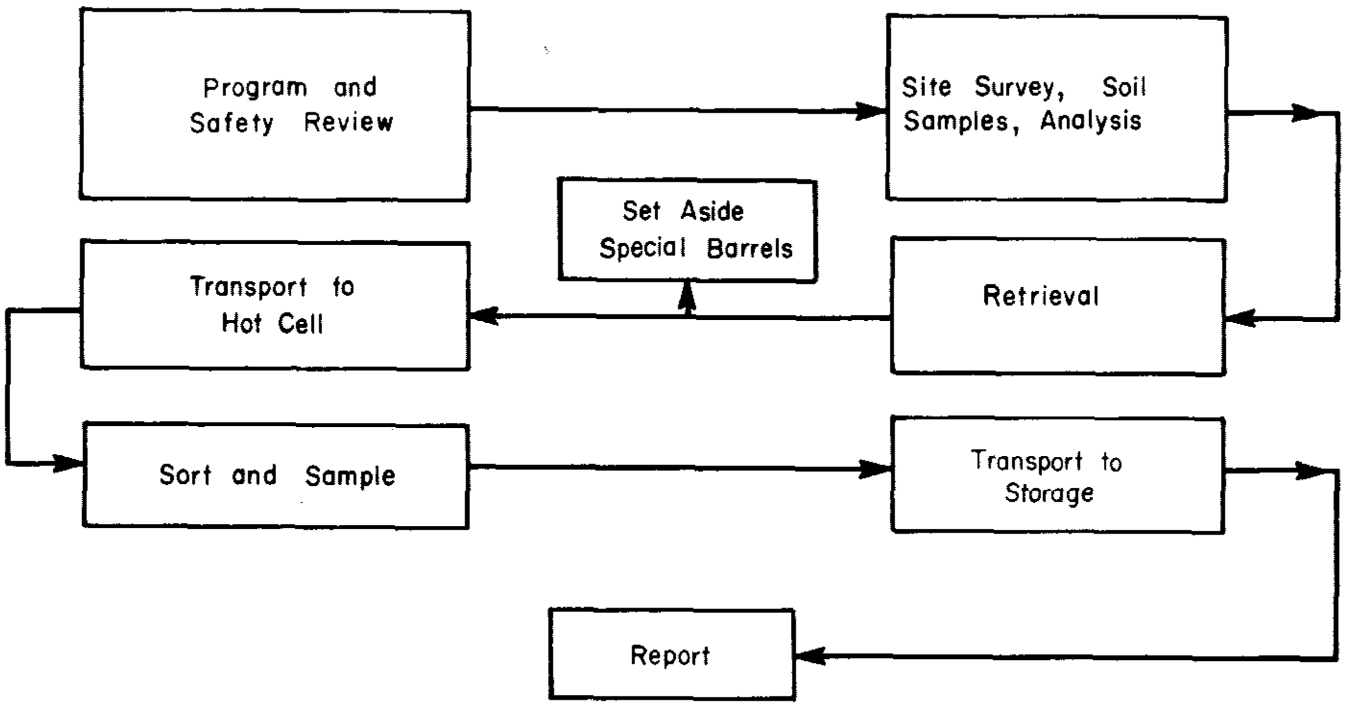

Fig. 2 SRWRT Program flow diagram.

Dempster-Dumpsters[a] to the hot cell facilities at the Auxiliary Reactor Area (ARA) where the containers were opened and sorted into two fractions--combustible and noncombustible. The wastes were photographed, sampled, repackaged, and returned to the Improved Temporary Storage Area (ITSA) pad at the NRTS Burial Ground. Of the three special barrels that the AEC requested retrieved, one was found and was set aside at the burial ground for disposition by the AEC. This report summarizes the findings of SRWRT and makes recommendations for future removal, treatment, and repackaging of the waste for ultimate storage.

[a] Registered trade mark for waste handling equipment shown in Figure 4.

II. DESCRIPTION OF THE WASTES AND THE NRTS BURIAL GROUND

A plot plan of the NRTS Burial Ground and the Interim Temporary Storage Area (ITSA) is shown in Figure 3. The original NRTS Burial Ground consisted of 13 acres of fenced ground at the extreme west end; the expansion to the present 88 acres was made to the east. The first excavations were mainly trenches, while the more recent excavations included many large pits. An above-ground storage area (ITSA pad) was developed in 1970 to provide more ready retrieval of waste containers contaminated with transuranic isotopes.

1. CHARACTER OF THE WASTE

Solid radioactive waste stored at the NRTS Burial Ground is composed of trash, including: broken equipment, lumber, paper, rags, plastic, and other solid debris present in industrial or research establishments. The main sources of these wastes are the AEC's operations at the Rocky Flats Plant and the NRTS operating facilities.

Unclassified contaminated solid wastes generated by the Rocky Flats Plant (RFP) are shipped to the NRTS. The activity shipped in these wastes varies depending upon programs being carried out. The plutonium- (and americium) contaminated solid waste generated at RFP can be put into eight categories: first-stage sludge (non-LSA)[a], second-stage sludge (non-LSA), evaporator salts (LSA), cemented liquids (non-LSA), grease (non-LSA), line-generated waste (non-LSA), nonline-generated waste (LSA), and crated waste (non-LSA). Sorting or segregation of these contaminated wastes at RFP is done mainly to facilitate measurement of the radioactive content and to aid in the processing of the material. In addition, other wastes including uranium, beryllium and laboratory material are shipped to the NRTS.

First-stage sludge, second-stage sludge, evaporator salts, cemented liquids, and grease are generated in the waste treatment plant for radioactive liquids. Aqueous liquids of low radioactivity but high chemical content are sent to the waste evaporator in the treatment plant. The evaporator bottoms are sent to a double-drum dryer where most of the remaining water is removed. Water vapor from the evaporator and drum dryer is discharged to the evaporator stack. The dried salts are drummed for shipment. Aqueous liquids containing high concentrations of radioactivity and chemicals are processed through two stages of decontamination in the treatment plant, using a ferric hydroxide carrier precipitation process. The resulting decontaminated aqueous waste is combined with low-radioactivity, high-chemical content waste and is processed in the waste evaporator mentioned above. The precipitate is removed from the supernatant liquid by vacuum filtration. The filter cakes are drummed for shipment as first- and second-stage sludges. Aqueous liquids of high-radioactivity but low-chemical content are decontaminated in the second stage of the waste treatment plant. The precipitate is filtered and drummed for shipment as

[a] LSA = low specific activity.

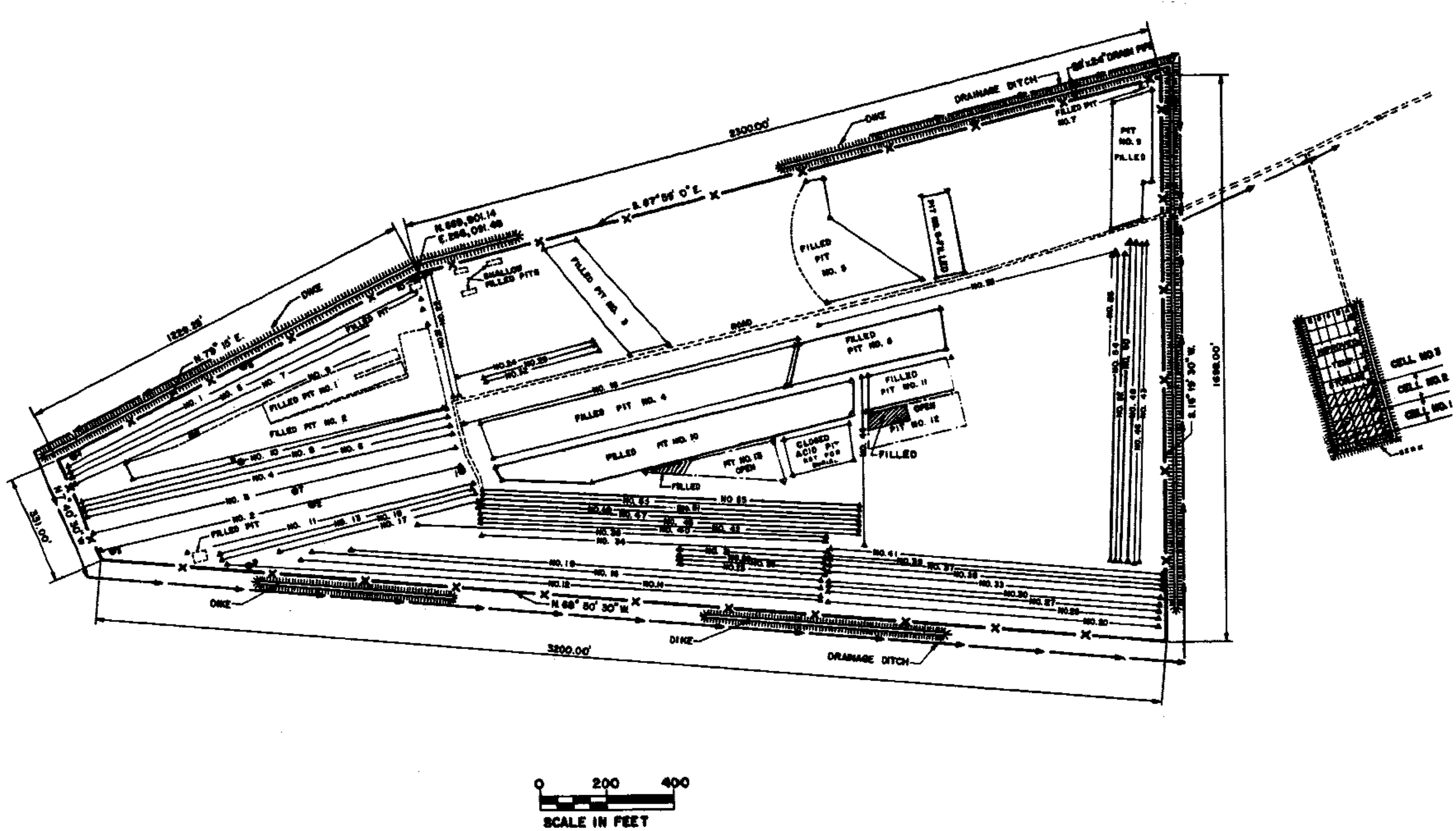

Fig. 3 Plot Plan of NRTS Burial Ground.

second-stage sludge. Aqueous wastes containing complexing agents are not amenable to the above precipitation process. They are discharged into lined drums filled with magnesia and cement to set up before shipment. These solids form the category called "cemented liquids." Ion exchange resins are cemented, also. Organic liquids, primarily cutting oil plus carbon tetrachloride, are shipped to the waste treatment plant where they are mixed with calcium silicate (Microcel-E) to form a putty-like mass called "grease." About 37 gallons of organic waste is converted to grease per 55-gal drum used for shipment.

Line-generated waste contains the bulk of the Pu discarded and shipped for burial. Line-generated waste is segregated at the point of generation according to type of waste material. These wastes are segregated by type to aid in assaying for nuclear materials accounting and to facilitate processing, including incineration, when necessary, to recover Pu. The type of matrix must be known to determine the Pu content. Wastes which contain more than the discard concentration of Pu are processed as scrap to recover the Pu. Wastes which contain less than the discard concentration are discarded as line-generated wastes.

Wastes removed from a radioactive material processing area (other than a processing line) are considered contaminated and are collected in drums as nonline-generated solid waste. Drums indicating greater than 0.5 mR/hr at the surface are assayed with a drum counter for possible Pu recovery. Nonline-generated waste which shows less than 0.5 mR/hr at the surface of the drum is considered LSA waste and shipped as such.

Items too large to put into drums are put into plastic-lined plywood boxes or crates. Within the past year, the outside of these crates or boxes has been coated with 1/8-in. thick fiber glass. These constitute the category called "crated wastes." The smallest crate is 4 by 4 by 7 ft and constitutes about 85% of those used. The largest one is 8 ft 9 in. by 8 ft 9 in. by 22 ft.

Nonline-generated Pu wastes are segregated from nonline-generated uranium wastes, since they are generated in separate buildings. However, until the first of 1970, they were not kept separate in shipment. Thus, drums of all categories of non-LSA Pu wastes were mixed in shipment and burial operations.

2. OPERATING EXPERIENCE AT THE NRTS BURIAL GROUND

Since April, 1954, waste, contaminated with fissionable fuel material has been shipped to the NRTS from the AEC's Rocky Flats establishment near Golden, Colorado. The first shipment was to have been an expedient trial to gain shipping, handling, and cost experience in comparison to alternative disposal methods--such as burial at sea or at other AEC land installations. Because no insurmountable problems were encountered, and because the NRTS operations provided economic advantages, the general practice of shipping these wastes to the NRTS still exists. However, changes in burial ground practices have occurred over the years. Table I shows the types of containers and estimated volume of Rocky Flats waste which has been deposited at the NRTS Burial Ground as of the end of 1970[2].

TABLE I

TYPES AND NUMBER OF CONTAINERS OF SOLID WASTES SHIPPED FROM ROCKY FLATS TO THE NRTS

Calendar Year	55-gal Drums Number	55-gal Drums Cu Ft	30-gal Drums Number	30-gal Drums Cu ft	40-gal Drums Number	40-gal Drums Cu Ft	Boxes (std)[a] Number	Boxes (std)[a] Cu Ft	Boxes (<std) Number	Boxes (<std) Cu Ft	Boxes (>std) Number	Boxes (>std) Cu Ft	Filters Number	Filters Cu ft	Cartons Number	Cartons Cu Ft
1954	1,705	12,617	2,265	11,325					5	50						
1955	4,381	32,419	174	870	53	318			7	106			1,205	5,664		
1956	4,773	35,320	11	55	1,054	6,324			8	106			2	9		
1957	7,138	52,821	535	2,925					61	2,367	3	672	1,251	5,880	101	2,112
1958	6,096	45,110	303	1,515	43	259			131	4,073	9	1,797	1,042	4,932	123	554
1959	7,833	58,334	119	595	5	30			139	5,399	7	1,268	1,679	7,891		
1960	7,689	56,399	30	150	1	6			160	8,104	22	3,257	130	611	34	156
1961	9,566	70,788	22	110	17	102			153	5,824	12	1,850	1,592	7,450		
1962	10,752	79,565	15	75	1	6			166	9,351	34	5,692	549	2,557	7	35
1963	12,012	88,889	4	20					199	13,835	87	13,732	535	2,065		
1964	11,383	84,234	2	10					168	10,120	211	33,645	1,023	4,927		
1965	9,784	72,402							91	4,493	280	41,476	762	3,581		
1966	13,596	100,610	12	60					59	3,344	454	64,345	575	3,101	10	95
1967	18,350	135,790	3	15			1	112	32	1,519	391	51,615	990	4,980	943	11,670
1968	19,118	141,473	66	330			425	47,600	76	5,850	588	95,555	323	2,433	4,267	52,484
1969	17,564	129,974	2,855	14,275			665	74,480	30	1,611	63	14,109	209	1,528	249	3,056
1970	22,321	165,175	741	3,705			1,380	154,560	59	3,431	62	15,686	641	4,679	43	529
Totals Number	184,111		7,207		1,174		2,471		1,544		2,223[b]		12,508[c]		5,782[d]	
Totals Cu Ft		1,362,420		36,035		7,045		276,752		79,663		344,699		62,288		70,691

[a] Standard Box - 84 in. by 48 in. by 48 in.

[b] Includes 875 boxes 84 in. by 48 in. by 52 in. and 273 boxes 84 in. by 48 in. by 50 in.

[c] Includes 24 in. by 24 in. by 14 in., 24 in. by 24 in. by 16 in., 24 in. by 24 in. by 18 in., 24 in. by 24 in. by 28, and 28 in. by 28 in. by 16 in. cartons of filters.

[d] Includes 5,496 cartons containing 55-gal drums.

Table II shows the estimated quantities of U, Pu and Am in the Rocky Flats wastes now stored at the NRTS[2].

Early shipments from Rocky Flats were put in trenches interspersed with NRTS wastes. As the volume of Rocky Flats material increased, the use of pits for burial was instituted, and a program of separation of NRTS and Rocky Flats wastes began.

The NRTS also was designated in May, 1960, as one of two Interim National Burial Grounds for disposal of waste from any source[3,4]. With the exception of the Rocky Flats waste shipments, this practice was discontinued in August, 1963[5,6]. During the period, 1960 to 1963, many varied wastes were buried at the NRTS Burial Ground. The materials included off-site waste from universities and private waste handlers and on-site waste--such as that generated at the SL-1 site following the SL-1 excursion.

Trenches are currently utilized for the burial of most of the waste which originates at the NRTS. These trenches average 10 ft deep, 6 to 8 ft wide, and vary in length. They are excavated on center lines 16 ft apart. Pasteboard boxes, 2 by 2 by 3 ft, and plastic wrapping are routinely used to contain the waste during transportation from the on-site plants to the burial ground. Figure 4 shows this material being deposited in the trenches. Space is conserved by tamping the wastes with a heavy steel plate dropped by a crane. The trenches are backfilled with a layer of 2 to 3 ft of soil so that the radiation level is reduced to less than 1.0 mR/hr at a point 3 ft above the surface. After the area is completely utilized, crested wheat grass (agropyron cristatum) is planted to reduce erosion and percolation of water through the regolith. Individual depositions are referenced approximately to the monuments at the end of the trenches and records maintained in case recovery becomes necessary. Shielded containers are used to transport wastes which emit excessively high levels of radiation. Transfer from the containers to the trenches is accomplished with a crane as shown in Figure 5.

Waste from Rocky Flats is shipped in wooden crates and 30- and 55-gal steel drums. Early Rocky Flats containers also included cardboard cartons. This waste emits very little external radiation and can be handled directly without shielding. Prior to November, 1963, Rocky Flats waste was hand-stacked (Figure 6); however, in the interest of economy and safety of personnel, a policy of dumping wastes was instituted (Figure 7). However, further increases in the quantities of Rocky Flats wastes shipped to the NRTS caused a return to stacking of wastes, starting in early 1970, to conserve space and improve retrievability. Segregation of transuranic-bearing wastes and non-transuranic waste is now done. Transuranic wastes are stored exclusively on the ITSA pad and all others, including NRTS wastes, are stored in the burial ground pits and trenches.

3. HYDROLOGY AND METEOROLOGY AT THE NRTS BURIAL GROUND

The regional ground water table in the vicinity of the NRTS Burial Ground is approximately 600 ft below the land surface. The nearest

TABLE II

ESTIMATED QUANTITIES OF URANIUM, PLUTONIUM, AND AMERICIUM IN ROCKY FLATS WASTES AT THE NRTS

Calendar[a] Year	U-238 (kg)	U-235 (g)	Pu-238 (g)	Pu-239 (g)	Pu-240 (g)	Pu-241 (g)	Pu-242 (g)	Am-141 (g)
1954	733	180	0.02	239	14	--	--	14
1955	979	870	0.15	1,529	95	5	0.3	26
1956	1,174	1,108	0.22	2,266	141	8	0.4	28
1957	2,147	1,616	0.30	3,184	198	12	0.5	43
1958	4,209	5,009	0.41	4,320	269	16	0.7	61
1959	3,753	11,319	0.46	4,800	299	18	0.8	62
1960	4,123	16,481	0.34	3,553	222	17	0.6	46
1961	4,311	13,921	0.53	5,538	346	26	1.0	70
1962	4,674	4,493	0.50	5,171	323	24	.9	180
1963	1,672	6,269	1.53	15,944	996	76	2.7	204
1964	1,339	7,888	1.79	18,586	1,161	89	3.2	238
1965	4,269	4,066	2.43	25,340	1,583	122	4.3	414
1966	53,452	1,688	8.73	90,820	5,674	438	15.5	2,815
1967	53,176	1,889	5.40	56,231	3,513	271	9.6	2,129
1968	33,373	1,210	4.18	43,543	2,720	210	7.4	1,778
1969	22,721	36,259	3.25	38,046	2,376	149	6.5	4,875
1970	7,084	14,196	2.58	24,178	1,517	105	5.2	1,834
Totals	203,194	128,467	32.82	343,288	21,447	1,586	59.6	14,817

[a] During calendar year 1967, there were 56 g of U-233.

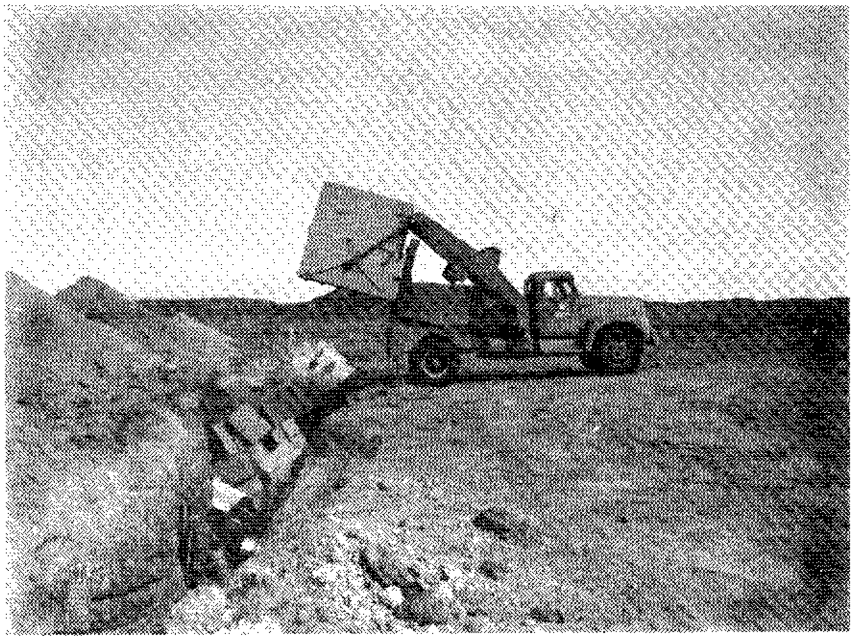

Fig. 4 Dumpster depositing waste in a trench.

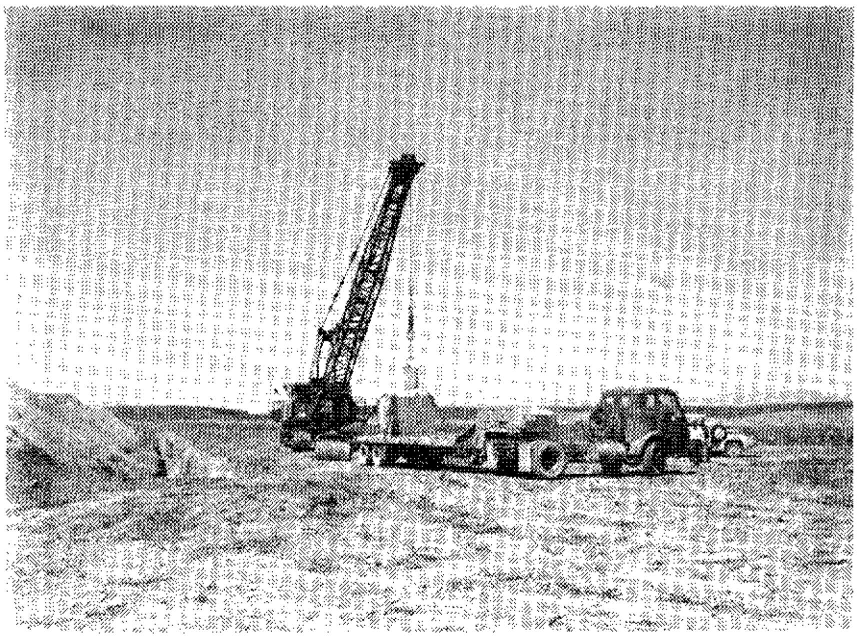

Fig. 5 Waste being transferred from a shielded container to a trench.

point down gradient where ground water is used is a stock watering well about 10 miles away. The nearest domestic well is about 55 miles down gradient. Before the ground water can be contaminated, radioactive waste would have to be leached to remove the contaminating nuclides. The solution would then have to pass through the surrounding soil, with its sorptive properties[7], and ultimately through the underlying basalt rock with interlayers of soil. The possibility and the probability of this occurring has been evaluated and found to be remote[7].

The average annual precipitation at the NRTS during the past 15 years has been about 8 in. Studies at the burial ground have shown that under well-drained natural circumstances, 96% of this precipitation is lost by evaporation or transpiration[8]. Therefore, the waste is subject to very little leaching, once it is covered and vegetation reestablished. Monitoring holes have been drilled to the basalt surface adjacent to the waste-filled trenches and pits. Moisture has been detected in these holes only twice during the past 10 years. In both cases, the moisture contained no detectable contamination.

III. SRWRT SUPPORTING ACTIVITIES AND TEST OPERATIONS

Supporting activities for SRWRT included those preparatory items which were required for the field and hot cell test operations. These activities consisted of (a) procedure preparation, (b) safety review, (c) equipment procurement, (d) test site selection, and (e) coordination. Test operations for SRWRT included those activities directly associated with the retrieval, sorting, and sampling of Rocky Flats wastes. The test operations consisted of (a) excavation of waste containers, (b) transportation of the waste containers, (c) sorting and sampling of specific waste containers at the ARA-I Hot Cell, and (d) return of the waste containers to the NRTS Burial Ground.

1. SUPPORTING ACTIVITIES

Procedures for each of the principal work activities were prepared as an initial step. The individual procedures were modified to reflect knowledge gained and comments from those groups who reviewed the procedures.

(1) Burial Ground Excavation and Transportation Procedure

(2) Sample, Photograph and Container Numbering Procedure

(3) Hot Cell Sorting and Sampling Procedure

(4) Analytical Procedure for Alpha Contaminant Determination

(5) SRWRT Handling Tools

Prior to field or hot cell work, formal approval of the procedures by an independent review committee (the ICPP Safety Review Board) was obtained. Preliminary review and comments were also obtained from other organizations involved with the program. These organizations were AEC-ID Waste Management Branch, OSTS Division, HSL, and Aerojet Nuclear Company NOS Division.

One of the important aspects of the supporting activities was detailed study of burial ground records and selection of sites for exhuming operation. Data relating to each load of waste sent to the NRTS Burial Ground are recorded on a standard form. Overall information such as type and level of contamination, number and type of waste containers, source of the material, shipping and burial date, and burial location are provided. Specific information on individual waste containers must be obtained from detailed records of Rocky Flats. These records show the type of container, weight, isotopic contamination, contamination level, and the source (building) for each individually numbered barrel.

Besides the sites of the three special barrels suspected of containing unknown amounts of Pu, three additional sites were selected for exhuming, based on the burial ground records, that would provide the best possible representative sampling of waste containers. The first site selected was Pit 11 where waste containers were expected to be in relatively good condition. This particular pit is a stacked array of about 18-month old waste. The second site selected was Pit 5 (a dumped pit) where the effects of age (about 7 years) and dumping could be studied. The third site selected was Pit 2 where the wastes were stacked, but quite old--approximately 12 years.

The selection of sites was based on the following considerations: (a) desire to open the pits as nearly like future operations as possible, (b) absence of significant quantities of beta-gamma wastes, and (c) variety of containers present at the site. By selecting sites of various ages, the effect of age on the container and contents could be studied, and the effect of changes in burial operating mode and Rocky Flats packaging philosophy could be determined.

It was not possible to make a statistical sampling, due to the large number of variables and the relatively small number of containers exhumed. In brief, the selection of sites was based on engineering judgment to obtain as much information as possible.

2. TEST OPERATIONS

The test operations at the NRTS Burial Ground were divided into separate phases. The first phase was the retrieval of three specific single barrels of Rocky Flats waste on which special additional measurements were desired. The second phase was retrieval of multiple barrels for transport to the ARA-I Hot Cell for detailed sorting and sampling studies.

Core samples were collected prior to excavation work to determine the general level of contamination that would be encountered. Standard hand-operated samplers were used to collect soil samples in the vicinity of the excavation work.

Safety equipment including wind speed and direction equipment, fire extinguishers, and a portable eye-wash was located near the site of each excavation. Other safety equipment such as dust respirators, full face masks, safety glasses, hard hats, anti-C clothing and plastic bags was kept at the excavation site and in the trailer located at the burial ground gate. Air samplers and required portable generators needed for collection of air samples were utilized continuously during excavation work. One sampler was placed upwind, and one was placed downwind at each excavation site. The filters were changed and analyzed for gross alpha, daily. For the most part, low volume (2 cfm) samplers were used, although, high volume (30 cfm) samplers also were available.

Barrels that were ruptured by excavating equipment, opened due to other causes, or barrels that showed surface contamination were bagged in plastic or put in larger 83-gal barrels, as shown in Figure 8. When plastic was used, the waste barrel was double bagged.

The use of smears or soil samples in conjunction with an alpha scintillation crystal and scaler was the most effective method of detecting alpha contamination. The available standard alpha instruments--such as the PAC-1S--were not effective in determining contamination due to a lack of sensitivity and interference of moisture and dirt in the work area.

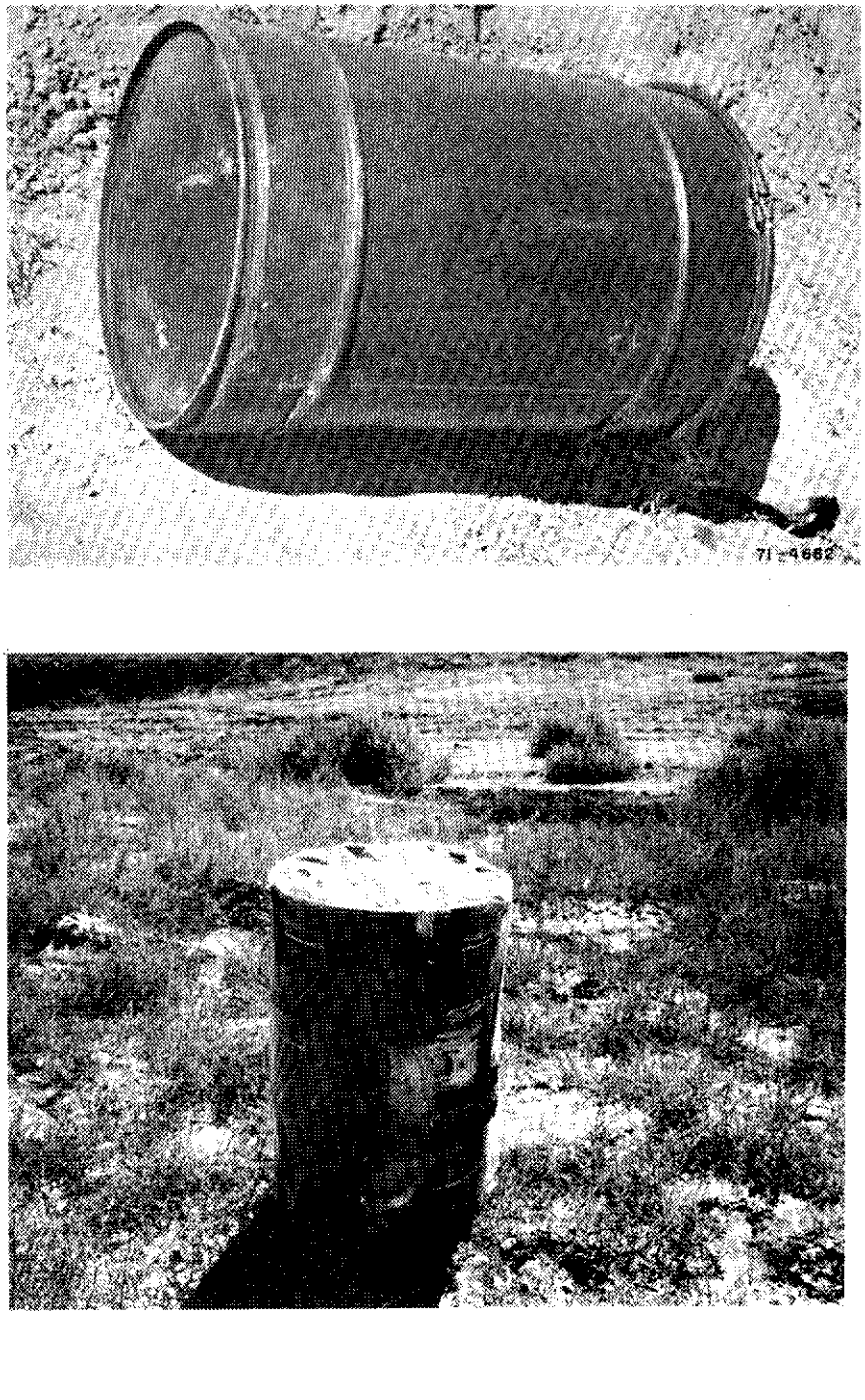

Fig. 8 Repackaged containers.

The standard health physics GM instruments were useful for general survey, particularly when Am was present, and to insure that NRTS beta-gamma wastes were not encountered unknowingly.

A backhoe with a 3/8 or 1/2 cu yd bucket was the main piece of heavy equipment used during earth-moving operations. The backhoe proved to be the most effective for dirt removal and damaged fewer drums than other equipment. A road grader and bulldozer with earth scraper were used in special instances. These latter pieces of equipment were useful in moving gross quantities of overburden and back filling, but when used for close-in work, they damaged an excessive number of containers. A crane or the backhoe, with a standard barrel chain-lifting device was used almost exclusively for removing barrels from the excavations. The crane had some advantages over the backhoe in that multiple chain-lifting devices could be used, and a larger area covered.

Considerable time was spent in hand-digging during the exhuming work. It was necessary to uncover barrels by hand, in conjunction with the backhoe, during the final steps in the stacked pits to prevent rupturing barrels. In "dumped" pits, more hand-digging was required because of the random barrel orientation. Using the backhoe near the barrels in the dumped pits caused excessive damage.

3. HOT CELL OPERATIONS

The Hot Cell at ARA-I was used to separate the waste into combustible and noncombustible fractions and to determine the condition of the waste and waste containers. Sixteen waste barrels from the NRTS Burial Ground were opened, segragated, and studied.

The ARA-I Hot Cell was selected for the sorting and sampling work. This facility has been used previously for alpha work[9]. The cell floor was covered with plastic sheeting and absorbent paper with appropriate barriers to limit the spread of contamination.

Nu-Con[a] Containment Areas (hoods) (Figure 9) were used to cover each barrel in the hot cell while segregating materials. The hoods provided one part of a double containment and double filtration system--ie, the Nu-Con system and the hot cell proper. The Nu-Con device has built-in glove-box type gloves, a sealed zipper opening, and access ports. The access ports interconnected Nu-Con areas, which allowed materials to be passed from the exhumed drum to two separate drums, one containing combustible material and the other, noncombustible material. An absolute filter was installed in the Nu-Con area on the exhumed drum and DOP tested prior to use. Since the three drums and Nu-Con areas were interconnected, air filtration and pressure equalization between the drums and the hot cell atmosphere was established.

Provisions were also made to package material items in a section of plastic tubing. An access port of the containment hood was fitted with a long section of plastic tubing sealed at the free end. Samples were passed into the tube and the tube sealed twice between the item and the Nu-Con area. This section of tubing was cut from the parent tube,

[a] Registered Trade Mark.

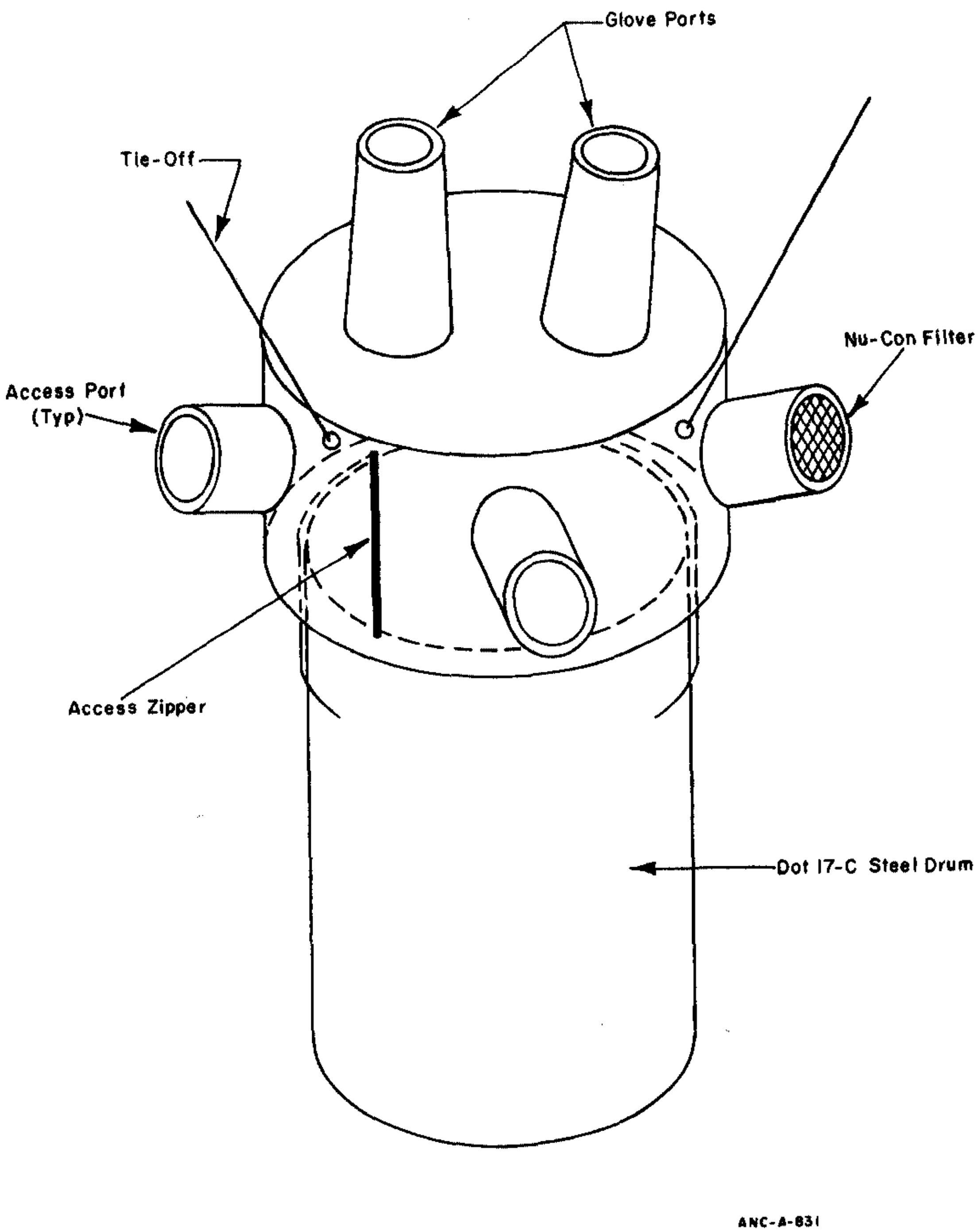

Fig. 9 Nu-Con Containment Area (hood).

resulting in a sealed sample package. Samples were double-bagged and shipped as Pu-contaminated materials to the ICPP Analytical Branch. After waste materials from the exhumed drums were sorted into new drums, sufficient adsorbent was placed in the liners to adsorb moisture, and the plastic liners in these drums were sealed. The Nu-Con areas were removed, more adsorbent placed in each drum, and the drums sealed. The drums were decontaminated in the hot cell, as needed, placed in plastic bags, and removed from the work area to the cell truck lock.

Materials and equipment used in the operation were packaged for hot waste disposal or decontaminated. Alpha-contaminated items--such as blotting paper, plastic, filters, clothing, etc--were placed in plastic bags and sealed in new barrels with two sealed plastic liners. These wastes were sent to the burial ground. Alpha-contaminated equipment was disposed as contaminated waste. The hot cell facility was decontaminated to radiation levels equal to, or less than, the radiation levels which existed prior to the program.